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SURVEY OF THE FISH FAUNA IN THE GRAMPIANS REGION, SOUTH-WESTERN VICTORIA

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Abstract: The distributions of fishes in the Grampians Region of south-western Victoria were determined by a survey carried out between October and December 1979. Thirteen species, 7 native and 6 exotic, were recorded. Fish distributions were related to stream order and to habitat characteristics. Habitat preference of individual species appeared to be the most important factor determining distribution. Cluster analysis of sampling sites based on the presence or absence of fish species showed that broad habitat types did contain characteristic faunal assemblages. The effect of exotic species on the distributions of native fishes was unclear but circumstantial evidence suggested a fragmentation of the range of mountain galaxias, *Galaxias olidus* Gunther, by brown trout, *Salmo trutta* Linneaus. The Grampians Region contained no single species or faunal assemblage not found elsewhere in Victoria. However, the eastern little galaxias, *Galaxiella pusilla* (Mack), was relatively common and the opportunity exists to preserve examples of the preferred habitat of this species.

The Grampians Region is one of the most important areas for wildlife in Western Victoria. It has been little altered by human settlement, primarily due to the steep and rocky nature of much of the terrain. During 1974 and 1975, the Fisheries and Wildlife Division, Victoria, conducted faunal surveys of the area (Emison *et al.* 1978). However, these surveys were concerned with terrestrial vertebrates and very few data were gathered on fishes. This paper presents the result of a survey of the fish fauna of the Grampians Region conducted between October and December 1979.

THE STUDY AREA

The area surveyed corresponds to region 2 of the four regions surveyed by Emison *et al.* (1978) and includes the whole of the Grampians Ranges together with the Black and Dundas Ranges, a total area of about 4530 km² of which about 48% is in public ownership (Fig. 1).

The ranges rise to an altitude of about 800 m and the elevated areas are steep and rocky with high runoffs. The low-lying areas consist of undulating deposits of sand with low runoffs and poorly defined water-courses due to seepage and evaporation loss. The average annual rainfall varies from 700 mm to more than 900 mm and average annual discharge from 560 ml/km², for MacKenzie River above Lake Wartook, to 48 ml/km² for the Wannon River above Dunkeld. Most discharge occurs during winter and spring.

The ranges are drained by the headwaters of the Glenelg, Wannon and Wimmera Rivers. The Glenelg River drains the western flanks and arises in the Victoria and Serra Ranges, initially following a northwesterly course through areas of swampland before turning southwesterly. It has one major storage in the study area, Rocklands Reservoir (built 1933, capacity 335 500 ML) and one small storage Moora Moora Reservoir (built 1933, capacity 62 900 ML). The Moora Moora channel, completed in 1930, allows water from the Glenelg to be directed into the Wimmera catchment.

The Wannon River drains the southern flanks of the ranges and follows a well-defined course only in its upper reaches, becoming increasingly swampy in the south and not normally flowing in summer. It has no major storages in the study area but a pipeline was installed in 1971 to direct winter flows from the headwaters northwards into Fyans Creek catchment. The Wannon and Glenelg Rivers meet to the southwest of the study area and the Glenelg continues until it enters the sea near the border between Victoria and South Australia.

The Wimmera River drains the northern and eastern flanks of the ranges and terminates at Lake Hindmarsh, 83 km north of the study area. Tributaries of the Wimmera River generally follow well-defined courses and two have major storages, Wartook Reservoir on MacKenzie River (built 1887, capacity 29 360 ML) and Bellfield Reservoir on Fyans Creek (built 1966, capacity 78 540 ML).

Areas of Crown Land contain a varied native flora, much of which remains in a relatively natural condition. Land has been cleared for agriculture in most areas outside Crown Land boundaries.

METHODS

Sampling was undertaken at 115 stations throughout the Grampians Region (Fig. 2) between 18 October and 17 December 1979 by electrofishing (82 stations), netting with a 1 mm diagonal stretch-mesh dip-net (37 stations, 8 of which were also sampled by electrofishing) and with 38 mm, 89 mm and 114 mm diagonal stretch-mesh gill nets (4 stations). Electrofishing was used to capture fish in easily-wadeable rivers. The length of river fished was normally 60 m (53 stations) although, where access was difficult, sampling was limited to 30 m (24 stations) and occasionally only isolated pools were sampled (5 stations). Dip-netting was used in slow-flowing backwaters and swamps where aquatic macrophytes were abundant. Gill nets were used in reservoirs and deep (>2 m) pools.

Fish were identified according to McDowall (1980c), and the length range (total length to nearest mm) and

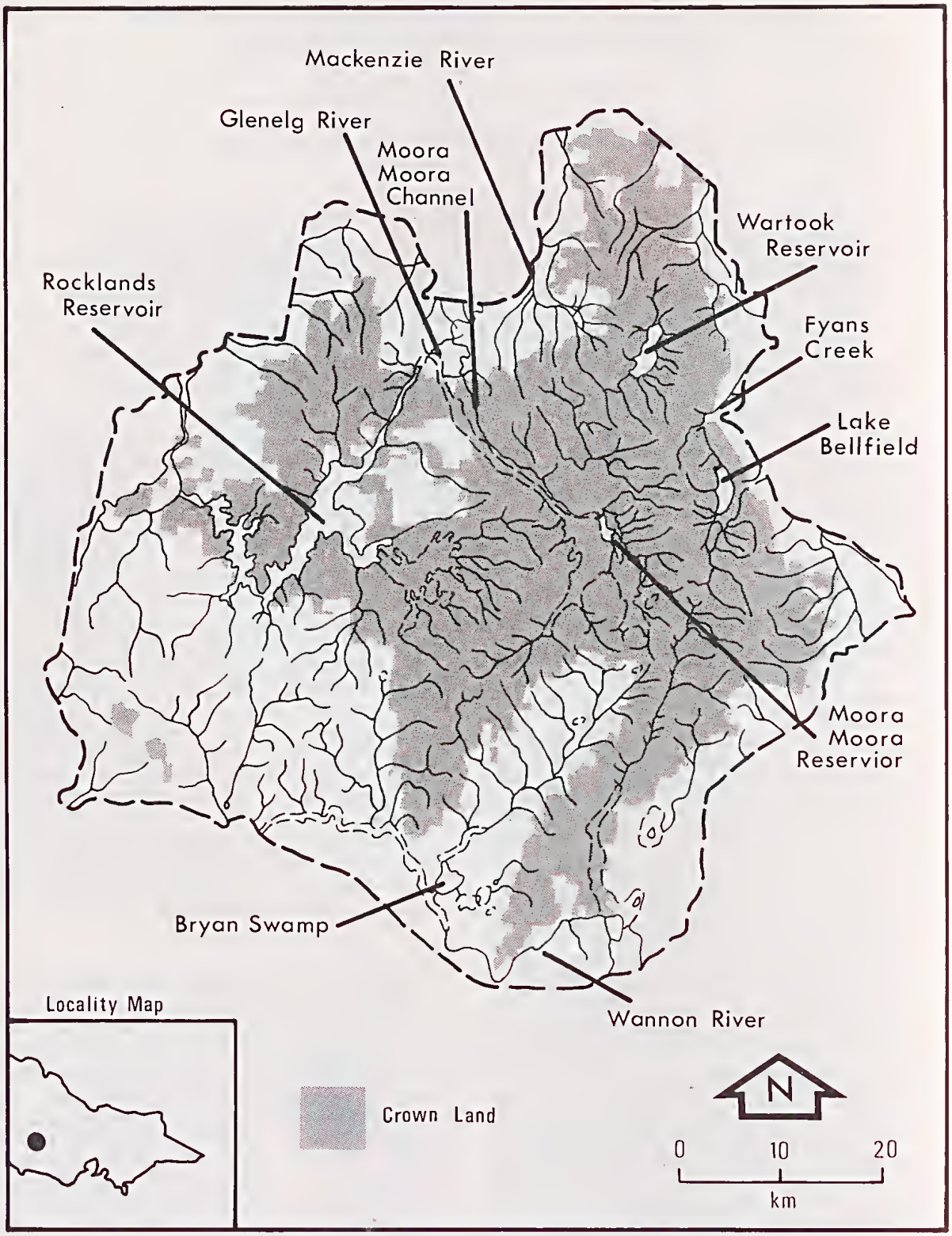

Fig. 1—Place names and areas of Crown Land in the Grampians Region.

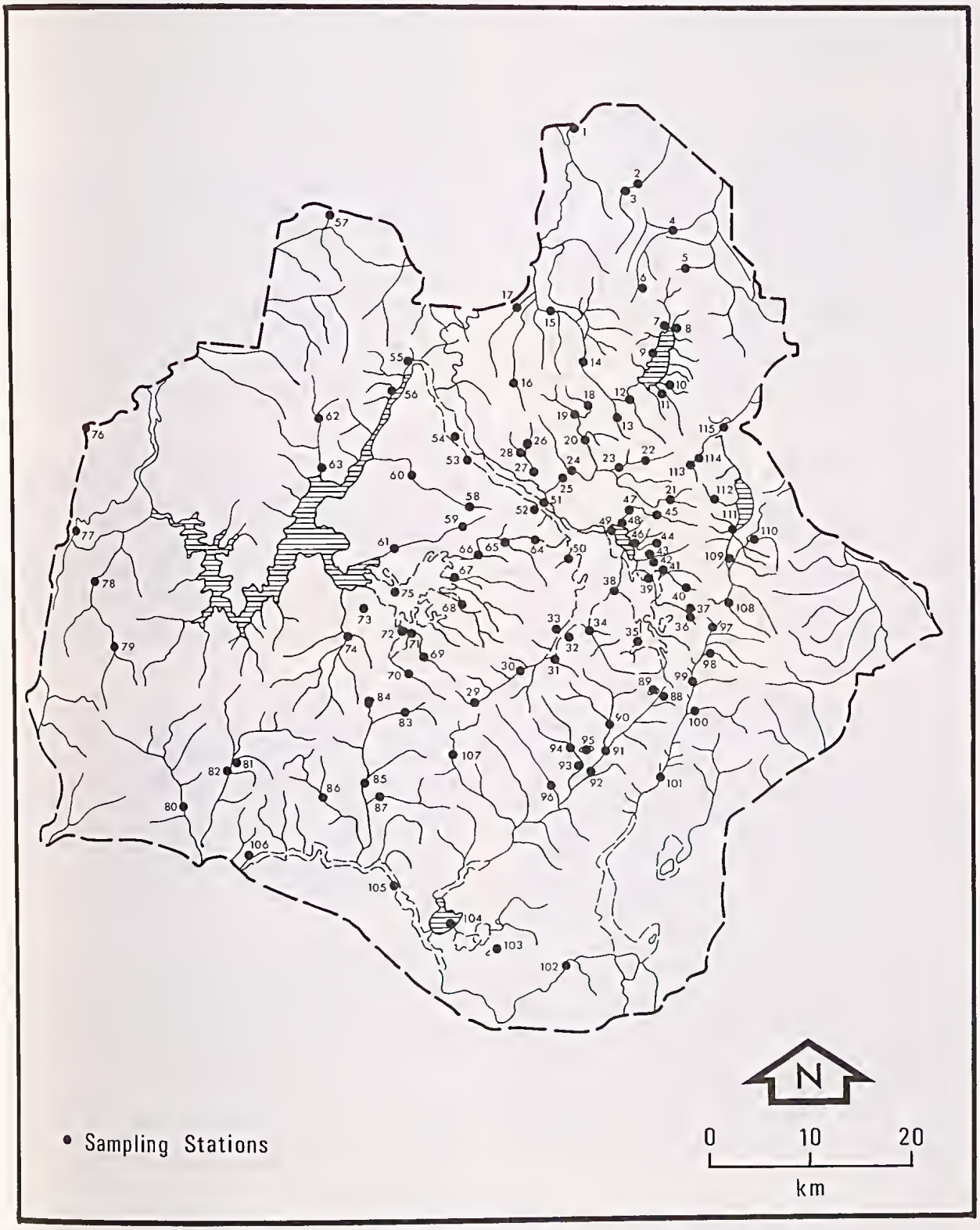

Fig. 2—Location of sampling stations in the Grampians Region.

TABLE 1
FISH SPECIES RECORDED FROM THE GRAMPIANS REGION TOGETHER WITH THEIR LENGTH AND WEIGHT RANGES

Family	Scientific Name	Total Length range (mm)	Weight range (g)
NATIVE SPECIES			
Gadopsidae			
	Gadopsis marmoratus Richardson	29-270	0.5-104.5
Galaxiidae			
	Galaxias olidus Gunther	25-130	0.1- 18.9
	Galaxiella pusilla (Mack)	9- 37	<0.1- 0.8
Kuhliidae			
	Nannoperca australis Gunther	9- 75	<0.1- 6.2
	Nannoperca obscure (Klunzinger)	12- 33	<0.1- 0.6
Eleotridae			
	Hypseleotris sp. 4 (undescribed)	20- 55	0.1- 1.8
	Philypnodon grandiceps (Krefft)	36- 77	0.4- 4.1
EXOTIC SPECIES			
Salmonidae			
	Salmo trutta Linnaeus	27-547	0.2-1864.5
	Salmo gairdnerii Richardson	321	428.8
Cyprinidae			
	Carassius auratus (Linnaeus)	11- 36	0.1- 0.8
	Tinca tinca (Linnaeus)	101-450	13.9- 925.0
Percidae			
	Perca fluviatilis Linnaeus	70-280	2.8- 326.0
Peociliidae			
	Gambusia affinis (Baird & Girard)	12- 33	0.1- 0.6

weight range (to the nearest 0.1 g) recorded for each species. Where identification was uncertain, specimens were preserved in 10% neutral formalin for later examination.

Following the style of Cadwallader (1979), for each station, the map reference, drainage system, approximate altitude, gradient and stream order (*sensu* Strahler 1957) were obtained from 1:100 000 topographical survey maps (Appendix). At each station the predominant substrate type and abundance of aquatic macrophytes were noted. Between 14 and 18 April 1980, some of the stations (Appendix) were re-visited to identify the more common species of aquatic macrophytes.

Cluster analysis was used to determine whether particular habitat types had characteristic faunal assemblages. Individual sampling sites were compared on the presence or absence of fish species using the flexible sorting method of Lance and Williams (1967) and the dissimilarity measure of Czekanowski (in Hellawell 1978). Sampling sites where no fish were captured were excluded from the analysis. The resultant clustering of sampling sites was represented graphically in the form of a dendrogram.

RESULTS

Fish were captured at all but 20 of the 115 stations. Thirteen species were recorded, 7 native to Australia and 6 exotic (Table 1). The freshwater blackfish, *Gadopsis marmoratus* Richardson, was the only native species to attain a size in excess of 200 mm: the remainder were generally smaller than 100 mm. Of the exotic species, brown trout, *Salmo trutta* Linnaeus; rainbow trout, *Salmo gairdnerii* Richardson; tench, *Tinca tinca* (Linnaeus); and redfin *Perca fluviatilis* Linnaeus, all exceeded 200 mm.

MOUNTAIN GALAXIAS

Mountain galaxias, *Galaxias olidus* Gunther, was the most widespread native species, occurring at 40 stations and in all three catchments (Fig. 3). The species was generally found in the high altitudes and steep gradients of first to third-order streams (Table 3), but was also recorded from the Moora Moora channel and Bryan Swamp. Most of these streams were flowing through undisturbed catchments (85% of stations) and were well-shaded by overhanging vegetation. Sand was the predominant substrate. Mountain galaxias was rarely associated with abundant aquatic macrophytes (Table 2).

BROWN TROUT

Occurring in both the Wimmera and Wannon systems, this species was recorded at 10 stations (Fig. 4). It was most commonly found in the higher altitudes and steeper gradients of the first to third-order streams and was present in Wartook Reservoir. Brown trout generally occurred (80% of stations) in streams flowing through undisturbed catchments, shaded by overhanging vegetation with little or no aquatic vegetation present. Brown trout occurred predominantly over a gravel substrate (Table 2).

FRESHWATER BLACKFISH

Freshwater blackfish occurred at 16 stations and in all three catchments (Fig. 5). It occurred at lower altitudes and in streams with gentler gradients than either mountain galaxias or brown trout. The species was most often found in streams flowing through undisturbed catchments and in slow-flowing stretches of water with abundant cover in the form of submerged logs, undercut banks and large boulders. Sand and gravel were the most common substrates (Table 2).

REDFIN

Occurring at 19 stations, this species was found in both the Glenelg and Wimmera catchments (Fig. 6). It occured throughout second to fifth-order streams (Table 3) and was most common in backwaters and pools, particularly in the slow-flowing areas of the Glenelg River. The species was also present in Wartook and Moora Moora Reservoirs. Redfin occurred most frequently over a mud substrate and was often associated with aquatic macrophytes (Table 2): the most common species were the common millfoil, *Myriophyllum propinquum*, and an unidentified species of *Villarsia*.

FLATHEAD GUDGEON

Flathead gudgeon, *Philypnodon grandiceps* (Krefft), occurred at 5 stations in the Glenelg and Wimmera catchments (Fig. 7). It was found in low-altitude, third and fourth-order streams (Table 3) and often (80% of stations) in areas where the catchment had been partially

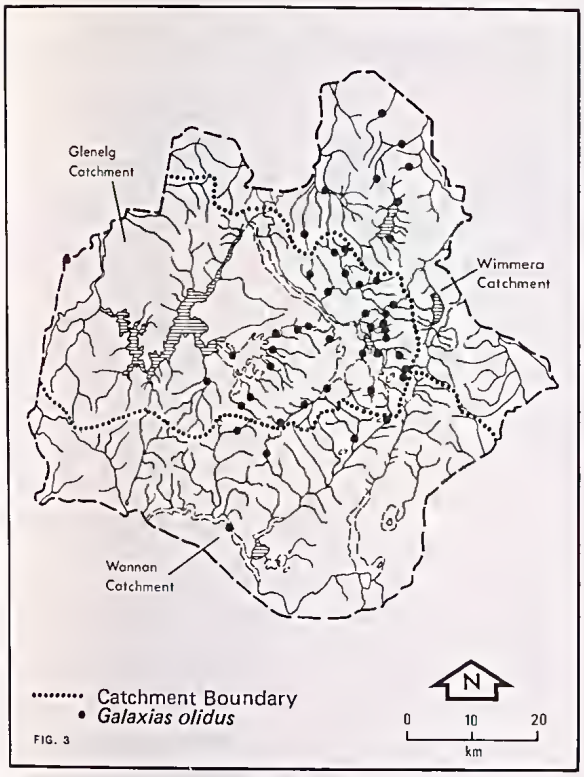

FIG. 3

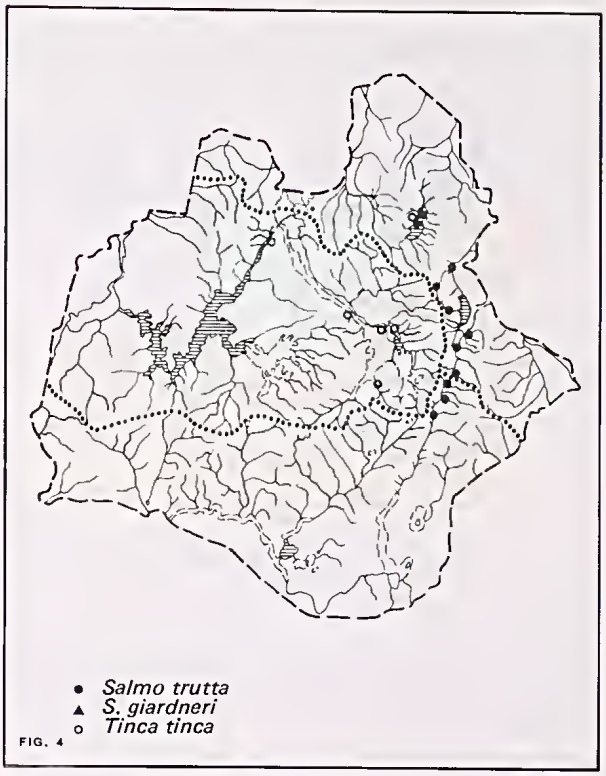

FIG. 4

FIG. 5

FIG. 6

Figs 3-6—Distribution of mountain galaxias, *Galaxias olidus* (3), brown trout, *Salmo gairdnerii*, and tench, *Tinca tinca* (4), freshwater blackfish, *Gadopsis marmoratus* (5), and redfin, *Perca fluviatilis* (6) in the Grampians Region. Boundaries (....) of the Glenelg, Wannon and Wimmera River catchments are shown.

TABLE 2
SUMMARY OF THE DISTRIBUTION OF FISH SPECIES IN RELATION TO ALTITUDE, THE GRADIENT, SUBSTRATE TYPE AND ABUNDANCE OF AQUATIC VEGETATION

Species	Altitude Mean (m)	Altitude Range (mm)	Gradient Mean (m/km)	Gradient Range (m/km)	Substrate type	% of Stations with abundant aquatic veg.
Galaxias olidus	287	150-600	27.5	0.0-200.0	S,(M),(B), (BD),(G)	29
Salmo trutta	374	220-560	35.0	0.0-133.3	G,(M),(BD),(B),(S)	20
Gadopsis marmoratus	264	150-440	11.1	0.9-128.6	S,G,(B),(M),(BD)	44
Perca fluviatilis	254	200-460	7.5	0.0- 28.6	M,(S),(G),(B)	50
Philypnodon grandiceps	242	150-440	4.6	0.9- 12.5	M,(G),(S),(BD)	40
Nannoperca australis	228	200-280	1.9	0.0- 4.6	M,(S),(B),(G)	75
Gambusia affinis	202	150-220	1.8	0.4- 5.4	M,(S)	58
Hypseleotris sp. 4	232	200-260	1.5	0.0- 3.7	M	100
Galaxiella pusilla	233	180-240	1.4	0.0- 3.8	M,(S)	87
Carassius auratus	205	180-220	1.3	0.0- 2.5	M,(S)	50
Tinca tinca	268	220-440	0.8	0.0- 3.4	M,(S)	60
Nannoperca obscura	220		0.0		M	100
Salmo gairdnerii	440		0.0		M	0

G, gravel; B, boulders; BD, bedrock; S, sand; M, mud.
Parentheses indicate substrate also present but not abundant.

cleared for agriculture. The species was most often associated with slow-flowing stretches of river and a mud substrate. Common species of aquatic macrophytes included millfoil and floating pondweed, *Potamogeton tricarinatus*.

Southern pigmy perch

Southern pigmy perch, *Nannoperca australis* (Gunther), was positively identified at 20 stations and occurred in all three catchments (Fig. 8). The open circles in Fig. 8 represent stations where southern pigmy perch was provisionally identified in the field but no specimens were taken. When these sites were revisited between 14 and 18 April 1980 they no longer contained water.

Southern pigmy perch was generally associated with pools and quiet backwaters found in low-lying streams and swamps and in the Moora Moora channel. Aquatic vegetation was often abundant (Table 2), the most common species being water ribbon, *Triglochin procera*, waterwort, *Elatine gratioloides*, and common millfoil. Mud was the predominant substrate.

Yarra pigmy perch

Yarra pigmy perch, *Nannoperca obscura* (Klunzinger), was taken from a small swamp in the Wannon Catchment (Fig. 8). Aquatic macrophytes were abundant, with species including common millfoil and water ribbon. The substrate was mud.

Mosquitofish

Mosquitofish, *Gambusia affinis* (Baird & Girard), was found at 12 stations and in both the Wimmera and Glenelg catchments (Fig. 9).

The species was recorded from second to fifth-order streams (Table 3) and was most common in the low-lying areas of the Glenelg catchment and always in association with pools and slow-flowing backwaters. It was present in the Moora Moora channel. Fifty percent of the stations at which mosquitofish was found occurred in areas partially cleared for agriculture. Aquatic vegetation, including common millfoil, floating pondweed and arrowgrass, *Triglochin striata*, was often abundant. Mud was the predominant substrate.

Midgley's carp gudgeon

Western carp gudgeon, *Hypseleotris klunzingeri*, has recently (Hoese 1980) been regarded as a complex of three separate species, of which Midgley's carp gudgeon is one. These species have yet to be formally described and identification of the Grampians specimen must be regarded as tentative. Specimens have been lodged with the Australian Museum (catalogue No. I. 21778-001).

Midgley's carp gudgeon was found at 5 stations in the Wannon catchment (Fig. 7) 4 of which were on Dwyer Creek, a small tributary of the Wannon River which flows through open pasture and into Bryan Swamp. The fish were captured in shallow, turbid pools with abundant aquatic macrophytes. The bottom substrate was mud.

Eastern little galaxias

Eastern little galaxias, *Galaxiella pusilla* (Mack), was found at 17 stations and in both the Wannon and Glenelg catchments (Fig. 10). It was found in second to fifth-order streams (Table 3) and in several swamps. The species was always associated with shallow, slow-flowing stretches of water and often with abundant aquatic macrophytes including common millfoil and water ribbon. Mud was the predominant substrate.

Goldfish

Goldfish, *Carassius auratus* (Linnaeus), occurred at 4 stations, 3 in the Glenelg Catchment and 1 in the Wimmera (Fig. 9). It was found in small, low-altitude tributaries flowing through farmland and always associated with mud-bottomed pools.

Tench

Tench, *Tinca Tinca* (Linnaeus), was found at 6 stations, 5 in the Glenelg and 1 in the Wimmera Catchment

TABLE 3
RELATIONSHIP BETWEEN FISH SPECIES DISTRIBUTION AND STREAM ORDER IN THE GLENELG, WANNON AND WIMMERA CATCHMENTS
Number of sampling stations in each stream order is given in parentheses.

	Stream order														
	Glenelg					Wannon					Wimmera				
Species	1(9)	2(20)	3(15)	4(3)	5(8)	1(1)	2(4)	3(8)	4(8)	5(2)	1(4)	2(8)	3(5)	4(5)	5(0)
Galaxias olidus	6	16	7	1	1		2	1	1	1	3	3	1	2	
Salmo trutta						1	1	1					4	1	
Gadopsis marmoratus		3	2	1	1			2	1					5	
Perca fluviatilis		3	6	1	3							1		3	
Philypnodon grandiceps			1		1									3	
Nannoperca australis		2	2	2	3		1	2	1			1		1	
Gambusia affinis		1	2	1	6							1			
Hypseleotris sp. 4							1	2	1						
Galaxiella pusilla		1	3		3		1	1	1					1	
Carassius auratus		1	1		1										
Tinca tinca		1			2										
Minimum no. of spp.	0	0	0	2	2	1	0	0	0	1	0	0	1	1	
Maximum no. of spp.	1	4	3	4	5	1	2	2	3	4	1	2	1	5	
Mean no. of spp.	0.7	1.4	1.8	3.0	2.9	1.0	1.0	1.0	1.0	2.5	0.7	0.7	1.0	2.8	

(Fig. 4). It was always found in pools with mud being the predominant substrate.

RAINBOW TROUT

One speciment of rainbow trout, *Salmo gairdnerii* Richardson, was captured in Lake Wartook (Fig. 4).

CLUSTER ANALYSIS OF SAMPLING SITES

To include data from those sites where southern pigmy perch was only provisionally identified, Yarra and southern pigmy perch were treated as a single taxon in the cluster analysis. Mountain galaxias was the only species recorded at 26 stations, thus forming an obvious grouping prior to the cluster analysis. So that the result was not unduly influenced by this group, only one of these 26 stations was included in the analysis.

The analysis grouped the sites into two main classes, with several subclasses evident (Fig. 11).

Class 1

Sites on generally permanent, clearly defined watercourses or reservoirs where predominant substrates were gravel, bedrock and sand. Aquatic vegetation was not often abundant. Six native species; freshwater blackfish, flathead gudgeon, pigmy perches, mountain galaxias and eastern little galaxias, and six introduced fishes; brown trout, rainbow trout, redfin, tench, mosquitofish and goldfish, occurred in this class.

Subclass A: Sites on low-gradient sections of the Wannon River and on Fyans Creek and MacKenzie River on the Wimmera system. Predominant substrates were gravel, bedrock and sand. Aquatic vegetation was often abundant (Table 4). The sites were well-shaded with eucalypt forest and cover, in the form of undercut banks and fallen timber, was abundant. Freshwater blackfish was the predominant species with brown trout and flathead gudgeon also present.

Subclass B: Sites on headwater tributaries of the Wannon, Glenelg and Wimmera systems not containing trout. The gradient was generally steep with bedrock and sand the predominant substrates and aquatic vegetation seldom abundant (Table 4). Sites were generally well-shaded by eucalypt forest and mountain galaxias was the dominant species (Fig. 12), being the only fish present at 26 of the 31 sampling stations. The only other fish occurring in this subclass was the freshwater blackfish.

Subclass C: Generally low-gradient sites (Table 4) on the main channels of the Wannon, Glenelg and Wimmera systems, flowing through open woodland, often with quiet backwaters and abundant aquatic vegetation. Sand and mud were the predominant substrates (Table 4). The Moora Moora and Wartook Reservoirs occurred in this grouping. Redfin was the dominant species (Fig. 12). Other fishes present were brown trout, rainbow trout, tench and the smaller species; goldfish, mosquitofish, mountain galaxias, eastern little galaxias, pigmy perch and flathead gudgeon.

Subclass D: Sites on the high altitude, generally steep-gradient headwaters (Table 4) of the Wannon River and Fyans Creek in the Wimmera system. Gravel, boulders and bedrock were the dominant substrates and aquatic vegetation was not often abundant (Table 4). Sites were generally well-shaded by eucalypt forest and brown trout was the only species present.

Class 2

Sites on swamps, isolated pools and watercourses of indeterminate drainage in open woodland or cleared grassland. Many sites were ephemeral, drying up in summer. Sand and mud were the predominant substrates and aquatic vegetation was often abundant (Table 4). The fish fauna consisted entirely of small species: six

Figs 7-10—Distribution of flathead gudgeon, *Philypnodon grandiceps*, and Midgley's carp gudgeon, *Hypseleotris* sp. 4 (7), Southern pigmy perch, *Nannoperca australis*, and Yarra pigmy perch, *Nannoperca obscura* (8), Mosquitofish, *Gambusia affinis* and goldfish *Carassius auratus* (9), and eastern little galaxias, *Galaxiella pusilla* (10) in the Grampians Region. Boundaries (....) of the Glenelg, Wannon and Wimmera River catchments are shown.

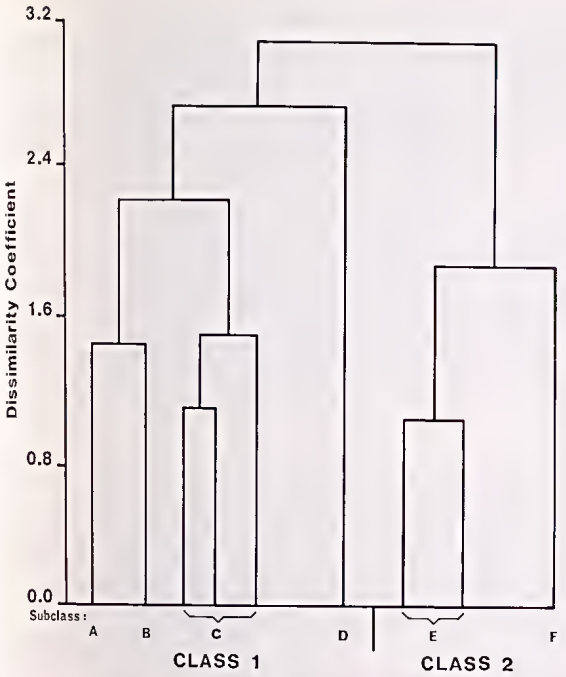

Fig. 11—Cluster analysis of sampling sites according to presence or absence of fish species.

native; pigmy perches, eastern little galaxias, mountain galaxias, Midgley's carp gudgeon and flathead gudgeon, and two introduced species; mosquitofish and goldfish.

The analysis indicated two subclasses (Fig. 11) with pigmy perch the dominant species in subclass E and eastern little galaxias the dominant species in subclass F (Fig. 12). No major physical differences were apparent among the sites although pigmy perch did not occur at any of the sites in subclass F.

DISCUSSION

Stream order analysis has been used by biologists in the Northern Hemisphere to investigate the distributions of fishes within river systems (Kuehne 1962, Harrel *et al.* 1967, Whiteside & McNatt 1972, Lotrich 1973) but has been used little in Australia (see Cadwallader 1979, Jackson & Williams 1980). In the present study, with the possible exception of mountain galaxias, which occurred most frequently in second and third-order streams (Table 3), there were no obvious distributional patterns related to stream order. The mean number of species per station did increase with increasing stream order (Table 3), probably reflecting an increase in diversity of available habitat, but the distribution of fishes in the Grampians Region may best be explained in terms of their habitat requirements.

Cluster analysis shows that sampling sites (Fig. 11) can be grouped according to their faunal assemblages and, furthermore, that these groupings do correspond to broad habitat types (Table 4). The most apparent differences are between those sites occurring on the more permanent, well defined watercourses (class 1 in Fig. 11) and those occurring on swamps, isolated pools (often of temporary nature), and areas of indeterminate drainage (class 2 in Fig. 11). The larger native and introduced fishes were only found at those sites in class 1 and the greatest diversity of fishes occurred in subclass C (Fig. 11) where the two habitat types overlap. In the overlap area, permanent waterways were combined with quiet, shallow backwaters often with abundant aquatic vegetation. The main channels provided suitable habitat for the larger fishes such as redfin, tench and freshwater blackfish and the backwaters contained the smaller species such as pigmy perch and eastern little galaxias.

Within those sites in class 1, fishes are further distributed according to their habitat preferences, illustrated by the dominant species in each particular subgroup (Fig. 12).

The preferred habitat of the freshwater blackfish is a slow-flowing section of river with abundant cover in the form of submerged logs, boulders or undercut banks (Jackson & Llewellyn 1980) and they were the dominant species in subgroup A (Fig. 12).

The mountain galaxias is primarily a small-stream species (McDowall 1980a) that penetrates the highland tributaries. It was the dominant species in subclass B (Fig. 12), a group of sites on headwater tributaries of the Wannon, Glenelg and Wimmera rivers.

Redfin is a species of still or slow-flowing waters, particularly where aquatic vegetation is abundant (McDowall 1980b). It was the dominant species in subclass C (Fig. 12), especially in those sites in the slower-flowing areas of the Glenelg River.

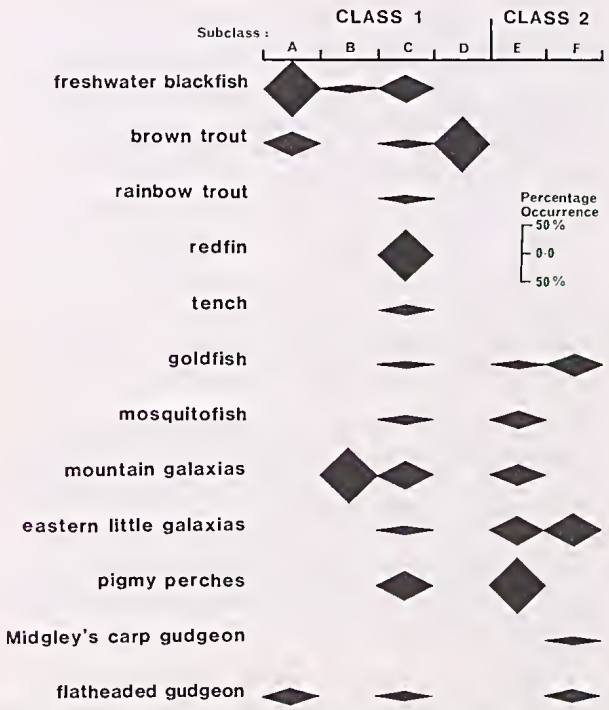

Fig. 12—Percentage occurrence of each fish species within each subclass identified by cluster analysis.

TABLE 4
SUMMARY OF THE ALTITUDE, GRADIENT, SUBSTRATE TYPE AND ABUNDANCE OF AQUATIC VEGETATION OCCURRING IN EACH SUBCLASS IDENTIFIED BY CLUSTER ANALYSIS

Class	Subclass	No. of Sites	Altitude Mean ± S.D. (m)	Altitude Range (m)	Gradient Median* (m/km)	Gradient Range (m/km)	% of stations with a particular substrate type dominant G	B	BD	S	M	% of stations with abundant aquatic vegetation
	A	5	276 ± 46.6	220-320	4.6	2.7- 10.5	40		20	20	20	75
	B	31	317 ± 104.0	200-600	28.6	2.1-100.0	10		40	37	13	3
1	C	21	260 ± 84.3	150-460	3.4	0.0- 28.6	12	2		45	40	52
	D	7	394 ± 78.9	320-560	28.6	11.8-133.3	36	21	29	7	7	14
	E	26	229 ± 30.2	200-270	0.6	0.0- 50.0	2	2		11	85	73
2	F	5	212 ± 22.8	180-240	1.9	0.0- 3.3			10	30	60	60

G, gravel; B, boulders; BD, bedrock; S, sand; M, mud.
* Due to the wide range of gradients recorded, the median rather than the mean value has been given.

Brown trout is restricted to cool, well-oxygenated waters and requires a gravel substrate and flowing water for reproduction (McDowall & Tilzey 1980). It was the only species present at the sites in subclass D, all of which were on the upper reaches of the Wannon River and Fyans Creek. Small trout (<50 mm total length) were present, suggesting that these trout populations are self-sustaining.

The relationships between the native and introduced fishes in Class 1 sites are difficult to ascertain but it would appear that mountain galaxias and brown trout do not co-exist. Mountain galaxias clearly dominate the headwater tributaries of all three river systems with the exception of the upper reaches of the Wannon River and Fyans Creek where brown trout occur. Mutually exclusive distributions of brown trout and mountain galaxias in highland streams on mainland Australia have been documented by several authors (Tilzey 1976, Cadwallader 1979, Fletcher 1979, Jackson & Williams 1980) and the distribution of these two species in the Grampians provides another example.

There were many sites on the headwater tributaries of the Glenelg River, containing mountain galaxias, which appear suitable for brown trout. The low-lying, swampy areas of the Glenelg River probably form a barrier preventing trout from Rockland Reservoir penetrating these tributaries, particularly in the summer when temperatures are high and oxygen concentrations low.

The sites within class 2 are dominated by pigmy perches and the eastern little galaxias, species which inhabit still waters with abundant aquatic vegetation (McDowall 1980c, Llewellyn 1980). The distribution of fishes within these sites must vary significantly seasonally as the shallow areas of swamp and backwater expand and contract. McDowall (1980a) has suggested that the eastern little galaxias may be able to aestivate but this has yet to be proven.

There is no evidence to suggest that the distribution of any of the native fishes in these still water areas have been affected by the introduction of exotic species. The native fishes occurred in most areas where the habitat was suitable. The clearing of land in some low-lying areas has had a visibly obvious effect on the aquatic habitat through the removal of shade vegetation, siltation and erosion caused by increased run-off. Twenty-nine percent of the stations occurring in cleared agricultural land contained no fish, compared with only 12 percent for all other stations.

The fact that only 7 native fishes were captured in the Grampians Region is typical of inland waters in Victoria, and reflects the generally depauperate nature of the fauna (Lake 1971, 1978, McDowall 1980c). The Grampians contain no single species or faunal assemblage not present elsewhere in Victoria, however, they do contain examples of several types of aquatic habitat that remain in a relatively pristine state. For example, many of the small tributaries of the Glenelg, remain relatively untouched and the region contains extensive areas of shallow swampland, examples of which are in increasing danger of being cleared and drained elsewhere in Victoria.

The results of the present survey could not be directly compared with those of Emison *et al.* (1978) as many of their data were drawn from sources other than the results of field surveys. However, they do record the presence of the eastern little galaxias at Greens Creek (station 34 in our survey) and suggest that this provides an opportunity for the preservation of a population of this species.

The eastern little galaxias occurs in other localities in Victoria but is particularly vulnerable to habitat alteration. Our results show that the species is widespread in the low-lying, swampy areas of the Grampians Region (Fig. 10) and that the area does indeed provide a unique opportunity to preserve examples of the habitat of this species.

The Moora Moora Channel, directing water from the Glenelg to the Wimmera System, and a pipeline which directs water from the upper reaches of the Wannon northwards into the Fyans Creek Catchment could enable fishes in the Grampians Region to move outside their natural ranges. The natural distribution of eastern little galaxias, for example, is limited to coastal

drainages. It occurred at a number of stations in the Glenelg River and was present in a drain emptying directly into the Moora Moora Reservoir (station 38). From there it would be possible for the species to enter the Moora Moora Channel and hence the Wimmera System.

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APPENDIX

Details of Sampling Stations in the Grampians Region and Fishing Method(s) used at each station. E, Electrofishing; D, Dip-netting; N, Gill-netting. Gl, Glenelg; Wa, Wannon; Wi, Wimmera. * Sites revisited in April 1980.

Station No.	Map No.	Reference	Altitude (m)	Gradient (m/km)	Stream order	Sampling method
1* Wi	7324	XE201184	180	5.4	2	E,D
2 Wi	7324	XE272127	200	200.0	2	E
3 Wi	7324	XE256122	360	9.5	2	E
4 Wi	7324	XE301086	200	6.9	3	E
5 Wi	7324	XE313048	220	22.2	2	E
6 Wi	7323	XE269024	320	133.3	1	E
7 Wi	7323	XE299002	460	4.2	2	E
8 Wi	7323	XE301002	460	4.9	1	E
9 Wi	7323	XD286967	440	0.0	Reservoir	N
10 Wi	7323	XD297932	460	8.3	2	E
11 Wi	7323	XD294929	460	10.0	2	E
12 Wi	7323	XD265920	440	12.5	4	E
13 Wi	7323	XD255900	460	25.0	1	E
14 Wi	7323	XD223946	240	10.5	4	E
15 Wi	7323	XE191004	200	2.8	4	E
16 Wi	7323	XD161929	260	18.1	2	E
17* Wi	7323	XE159008	200	0.0	Swamp	D
18 Gl	7323	XD226909	400	20.0	1	E
19 Gl	7323	XD213900	380	25.0	2	E
20 Gl	7323	XD227872	280	28.6	3	E
21 Gl	7323	XD311815	600	66.7	1	E
22 Gl	7323	XD281861	300	28.6	2	E
23* Gl	7323	XD258848	250	7.1	3	E
24* Gl	7323	XD212846	240	2.9	3	D
25* Gl	7323	XD206840	240	2.9	3	D
26 Gl	7323	XD171869	260	33.3	2	E
27* Gl	7323	XD180844	220	0.0	Swamp	D
28 Gl	7323	XD169863	260	25.0	1	E
29 Gl	7323	XD143635	300	28.6	2	E
30 Gl	7323	XD172659	300	28.6	3	E
31* Gl	7323	XD201671	260	5.4	2	D
32* Gl	7323	XD209694	250	4.6	4	E,D
33 Gl	7323	XD208697	260	100.0	1	E
34 Gl	7323	XD233702	240	3.4	2	E,D
35 Gl	7323	XD281690	250	11.1	2	E
36 Gl	7323	XD324717	320	50.0	3	E
37 Gl	7323	XD324716	320	50.0	1	E
38 Gl	7323	XD259739	220	0.4	Drain	E,D
39* Gl	7323	XD293746	230	3.8	4	D
40 Gl	7323	XD322728	280	66.7	2	E
41 Gl	7323	XD315748	260	66.7	2	E
42 Gl	7323	XD305769	280	23.5	2	E
43 Gl	7323	XD298779	280	40.0	1	E
44 Gl	7323	XD290786	260	66.7	1	E
45 Gl	7323	XD294809	480	40.0	2	E
46* Gl	7323	XD281782	230	12.1	2	E
47 Gl	7323	XD267808	240	12.5	2	E
48 Gl	7323	XD253793	220	0.0	Reservoir	N
49* Gl	7323	XD248789	220	0.4	Drain	E
50 Gl	7323	XD211766	240	33.3	1	E
51 Gl	7323	XD187809	220	0.6	5	D
52 Gl	7323	XD188805	220	0.6	5	N
53 Gl	7323	XD121859	210	0.6	5	D
54 Gl	7323	XD112878	210	0.6	5	E
55* Gl	7323	XD056936	220	0.6	5	D
56 Gl	7323	XD054921	220	0.6	5	N
57 Wi	7324	WE962092	170	0.0	Swamp	D

APPENDIX (*Continued*)

Station No.	Map No.	Reference	Altitude (m)	Gradient (m/km)	Stream order	Sampling method
58 Gl	7323	XD113815	260	22.2	1	E
59 Gl	7323	XD110793	240	16.7	2	E
60 Gl	7323	XD068847	220	2.5	2	D
61 Gl	7323	XD058771	200	4.1	3	D
62 Gl	7323	WD981883	220	4.1	3	E,D
63 Gl	7323	WD984838	200	0.6	3	E
64 Gl	7323	XD169780	540	28.6	2	E
65 Gl	7323	XD152776	460	13.3	3	E
66 Gl	7323	XD126760	230	22.2	2	E
67 Gl	7323	XD124748	240	10.0	2	E
68 Gl	7323	XD106729	220	3.3	2	E
69 Gl	7323	XD083666	280	33.3	1	E
70 Gl	7323	XD071649	280	50.0	2	E
71* Gl	7323	XD063696	220	2.7	3	D
72 Gl	7323	XD057696	220	2.7	3	E
73* Gl	7323	XD027703	210	0.0	Swamp	D
74 Gl	7323	XD007670	220	2.1	3	D
75 Gl	7323	XD057730	200	2.3	4	E,D
76* Gl	7223	WD752877	150	0.9	5	E,D
77 Gl	7223	WD749772	180	0.6	5	D
78 Gl	7223	WD769715	200	3.3	3	E
79 Gl	7223	WD793663	230	4.1	3	E
80 Wa	7223	WD866516	220	2.8	4	D
81 Wa	7323	WD909559	230	2.1	4	D
82 Wa	7323	WD908553	230	2.1	4	E
83 Wa	7323	XD061627	260	44.4	2	E
84* Wa	7323	XD037623	230	0.0	Swamp	D
85* Wa	7323	XD029546	220	0.8	3	D
86 Wa	7323	WD996528	220	5.4	3	E
87 Wa	7323	XD052537	230	5.5	3	E
88* Wa	7323	XD298634	280	8.7	2	D
89* Wa	7323	XD285632	270	0.0	Swamp	D
90* Wa	7323	XD255610	260	3.7	4	D
91 Wa	7323	XD244573	220	1.9	4	D
92 Wa	7323	XD242570	220	1.9	4	E
93 Wa	7323	XD223579	240	1.8	3	D
94 Wa	7323	XD222585	240	1.8	3	E
95 Wa	7323	XD233586	240	0.0	Swamp	D
96 Wa	7323	XD197561	240	5.0	2	E
97 Wa	7423	XD352700	400	11.8	3	E
98 Wa	7423	XD346618	380	44.4	2	E
99 Wa	7423	XD332653	320	4.6	4	E
100 Wa	7423	XD333625	320	8.7	3	E
101* Wa	7423	XD304558	280	2.7	4	E
102* Wa	7322	XD216375	240	1.2	4	E
103* Wa	7322	XD162389	220	0.0	Swamp	D
104* Wa	7322	XD119414	200	0.0	Swamp	D
105* Wa	7322	XD062459	200	0.1	5	E,D
106 Wa	7322	WD929472	200	0.1	5	D
107 Wa	7323	XD113577	260	18.2	3	E
108 Wi	7423	XD364730	400	28.6	3	E
109 Wi	7423	XD363772	360	28.6	3	E
110 Wi	7423	XD374788	340	133.3	3	E
111 Wi	7423	XD368800	280	9.1	4	E
112 Wi	7423	XD357818	320	28.6	3	E
113 Wi	7323	XD324861	560	66.7	1	E
114 Wi	7323	XD327862	520	66.7	2	E
115 Wi	7423	XD351894	220	3.6	4	E